PATENT ABSTRACTS OF JAPAN

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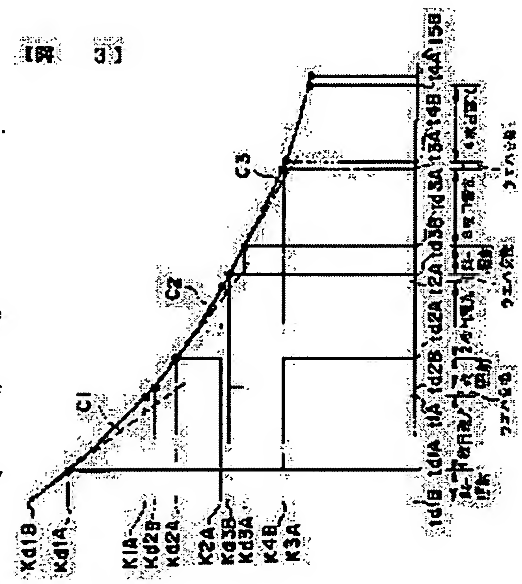
(54) **ALIGNER, EXPOSING METHOD AND MANUFACTURING METHOD OF SEMICONDUCTOR DEVICE**

(57)Abstract:
PROBLEM TO BE SOLVED: To make illuminance of the exposure light on a photosensitive board a target value, irrespective of change of transmittance of an optical system which changes over time.
SOLUTION: When first to third wafers 25 are exposed to light, dummy irradiation wherein one hundred pulse light are generated is performed before start of exposure. Pulse light for measuring transmittance are generated before and after dummy irradiation, and transmittance of an optical system is calculated by taking in output signals of an integrator sensor 10 and an illuminance sensor 28. Predictive characteristic Cm of transmittance change with time is calculated from the two calculated transmittances. When the fourth wafer 25 is exposed to light, predictive characteristic D4 of transmittance change over time is calculated from two transmittances of the optical system which are calculated before and after exposure of the third wafer 25, and predictive characteristic E4 of transmittance change with time which is corrected by difference Δd34 of transmittances between he transmittance after exposure of the third wafer 25 and transmittance before start of exposure of the fourth wafer 25. After the fifth wafer, calculation is performed by the same way. On the basis of the calculated predictive characteristics of transmittance change with time, transmittance of the optical system is calculated by the elapsed time of exposure, and the intensity of an exposure light when exposure is performed is controlled.



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CLAIMS

[Claim(s)]
[Claim 1] In an exposure method which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light Before imprinting an image of said pattern to the 1st predetermined side, the 1st attenuation factor of said exposure light which passes said optical system is measured. After imprinting an image of said pattern to said 1st predetermined side, the 2nd attenuation factor of said exposure light which passes said optical system is measured. Before imprinting an image of said pattern to the 2nd different predetermined side from said 1st predetermined side An exposure method characterized by measuring the 3rd attenuation factor of said exposure light which passes said optical system, and controlling light exposure of said exposure light to said 2nd predetermined side based on said 1st, 2nd, and 3rd attenuation factor.
[Claim 2] An exposure method characterized by predicting time amount change of the optical property of said optical system based on said the 1st attenuation factor and 2nd attenuation factor, and amending said predicted time amount change in an exposure method according to claim 1 based on said 3rd attenuation factor.
[Claim 3] It is the exposure method characterized by performing prediction of said time amount change in an exposure method according to claim 2 by carrying out approximation amendment of said the 1st attenuation factor and 2nd attenuation factor.
[Claim 4] It is the exposure method characterized by said thing [that amendment of predicted time amount change amends difference of said 2nd attenuation factor and said 3rd attenuation factor] in an exposure method according to claim 2.
[Claim 5] Said optical system is the exposure method characterized by having an illumination-light study system which illuminates a mask with which said pattern was formed in an exposure method according to claim 1, and projection optics which imprints an image of said pattern to said 1st or 2nd predetermined side.
[Claim 6] It is the exposure method which said 1st predetermined side is a sensitization side of a substrate of eye ** (n-1), and is characterized by said 2nd predetermined side being a sensitization side of the n-th substrate in an exposure method according to claim 1.
[Claim 7] In an exposure method which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light The 1st control method which predicts an attenuation factor of said exposure light which passes said optical system, and controls light exposure by said exposure light to said predetermined side, And it has the 2nd control method which predicts an attenuation factor of said exposure light which passes said different optical system from said 1st control method, and controls light exposure by said exposure light to said predetermined side. An exposure method characterized by imprinting an image of said pattern on said predetermined side at least by one control method of said 1st and 2nd control methods.
[Claim 8] In an exposure method according to claim 7 said 1st control method The 1st attenuation factor of said exposure light which passes said optical system before imprinting an image of said pattern to the 1st predetermined side, The 2nd attenuation factor of said exposure light which passes said optical system after imprinting an image of said pattern to said 1st predetermined side, Said 1st predetermined side is what controls light exposure of said exposure light to said 2nd predetermined side based on the 3rd attenuation factor of said exposure light which passes said optical system before imprinting an image of said pattern to the 2nd different predetermined side. An attenuation factor of said exposure light which passes said optical system before said 2nd control method imprints an image of said pattern to the 3rd predetermined side, An exposure method characterized by being what controls light exposure of said exposure light to said 3rd predetermined side based on an attenuation factor of said exposure light which passes said optical system after carrying out the predetermined time exposure of said exposure light at said optical system.
[Claim 9] It is the exposure method characterized by measuring an attenuation factor of said exposure light which passes said optical system during an exposure of said predetermined time [on an exposure method according to claim 8 and as opposed to said optical system in said 2nd control method], and controlling said light exposure based on said attenuation factor exposure before of said predetermined time, after an exposure, and under exposure.
[Claim 10] Said 2nd control method is the exposure method characterized by changing said predetermined time according to a mask with which said pattern was formed in an exposure method according to claim 8.
[Claim 11] It is the exposure method characterized by applying said 2nd control method in an exposure method according to claim 9 after an aligner starts exposure actuation until it carries out predetermined time progress, and applying said 1st control method after [said] carrying out predetermined time progress.
[Claim 12] It is the exposure method characterized by being applied when being started after exposure actuation carries out a predetermined time halt of said 2nd control method in an exposure method according to claim 9.
[Claim 13] In an exposure method according to claim 8 said 2nd control method Moving a mask with which an electric eye which receives said exposure light has been arranged, and said pattern was formed on said predetermined side and an abbreviation same side in the predetermined direction A light-receiving result of said electric eye [receive said exposure light by said electric eye through said optical system, and] before migration of said mask, An exposure method characterized by controlling light exposure by said exposure light to said predetermined side top based on a light-receiving result of said electric eye under migration of said mask or after migration.
[Claim 14] It is the exposure method characterized by corresponding to time amount to which said predetermined time exposes at least one shot field of said photosensitive substrate in an exposure method according to claim 8.
[Claim 15] In an exposure method which imprints an image of a pattern illuminated with said exposure light on a predetermined side

through optical system arranged in an optical path of exposure light The predetermined time exposure of said exposure light is carried out at said optical system, moving a mask with which said pattern was formed in the predetermined direction, before imprinting an image of said pattern to said predetermined side. An exposure method characterized by controlling said light exposure based on an attenuation factor of said exposure light which passes said optical system before an exposure of said predetermined time, and after an exposure.

[Claim 16] In an exposure method which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light Moving a mask with which an electric eye which receives said exposure light has been arranged, and said pattern was formed on said predetermined side and an abbreviation same side in the predetermined direction A light-receiving result of said electric eye [receive said exposure light by said electric eye through said optical system, and] before migration of said mask, An exposure method characterized by controlling light exposure by said exposure light to said predetermined side top based on a light-receiving result of said electric eye under migration of said mask or after migration.

[Claim 17] In an exposure method which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light Said exposure light which passed through the outside of an optical axis of said optical system and a shaft is received by light sensing portion to coincidence, respectively. An exposure method characterized by controlling said light exposure according to an attenuation factor of said exposure light which measures an attenuation factor of said exposure light which passes said optical system based on a light-receiving result of said light sensing portion, and passes said optical system.

[Claim 18] It has optical system which projects an image of a pattern illuminated with exposure light from the light source for exposure on a photosensitive substrate. In an exposure method which measures an attenuation factor of said exposure light which passes said optical system when plurality differs, and controls light exposure on said substrate based on attenuation factor data of these plurality Either of the 2nd light-receiving method which receives exposure light which passes through the outside of the 1st light-receiving method which receives exposure light which passes an optical axis of said optical system, an optical axis of said optical system, and a shaft is chosen. An exposure method characterized by controlling said light exposure according to an attenuation factor of said exposure light which measures an attenuation factor of said exposure light which passes said optical system based on a light-receiving result by this selected light-receiving method, and passes said optical system.

[Claim 19] An aligner which imprints an image of a pattern illuminated with said exposure light through optical system arranged in an optical path of exposure light characterized by providing the following on a predetermined side The 1st attenuation factor of said exposure light which passes said optical system before imprinting an image of said pattern to the 1st predetermined side The 2nd attenuation factor of said exposure light which passes said optical system after imprinting an image of said pattern to said 1st predetermined side A measurement means to measure the 3rd attenuation factor of said exposure light which passes said optical system before imprinting an image of said pattern to the 2nd different predetermined side from said 1st predetermined side A control means which controls light exposure of said exposure light to said 2nd predetermined side based on said 1st, 2nd, and 3rd attenuation factor

[Claim 20] An aligner which imprints an image of a pattern illuminated with said exposure light through optical system arranged in an optical path of exposure light characterized by providing the following on a predetermined side A prediction means to predict an attenuation factor of said exposure light which passes said optical system by either at least among the 2nd prediction method which predicts an attenuation factor of said exposure light which passes said different optical system from the 1st prediction method which predicts an attenuation factor of said exposure light which passes said optical system, and the 1st prediction method A control means which controls light exposure by said exposure light to said predetermined side based on an attenuation factor of said optical system predicted by said prediction means, and imprints an image of said pattern on said predetermined side

[Claim 21] In a method of manufacturing a semiconductor device with an aligner which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light Before imprinting an image of said pattern to the 1st predetermined side, the 1st attenuation factor of said exposure light which passes said optical system is measured. After imprinting an image of said pattern to said 1st predetermined side, the 2nd attenuation factor of said exposure light which passes said optical system is measured. Before imprinting an image of said pattern to the 2nd different predetermined side from said 1st predetermined side A manufacture method of a semiconductor device characterized by measuring the 3rd attenuation factor of said exposure light which passes said optical system, controlling light exposure of said exposure light to said 2nd predetermined side based on said 1st, 2nd, and 3rd attenuation factor, and imprinting and manufacturing an image of said pattern on said predetermined side.

[Claim 22] In a method of manufacturing a semiconductor device with an aligner which imprints an image of a pattern illuminated with said exposure light on a predetermined side through optical system arranged in an optical path of exposure light The 1st control method which predicts an attenuation factor of said exposure light which passes said optical system, and controls light exposure by said exposure light to said predetermined side, And it has the 2nd control method which predicts an attenuation factor of said exposure light which passes said optical system unlike said 1st control method, and controls light exposure by said exposure light to said predetermined side. A manufacture method of a semiconductor device characterized by imprinting an image of said pattern on said predetermined side at least by one control method of said 1st and 2nd control methods, and manufacturing.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the aligner for imprinting the image of the pattern of the original editions, such as a mask or a reticle (it considers as a mask hereafter), on photosensitive substrates, such as a wafer, at the optical lithography production process for manufacturing semiconductor devices, such as image sensors, such as semiconductor devices, such as LSI, and CCD, a liquid crystal display element, or the thin film magnetic head, the exposure method using the aligner, and the manufacture method of a semiconductor device.
[0002]
[Description of the Prior Art] With high integration of a semiconductor device, in order to manufacture the semiconductor device, the advance [long legs aligner / which is used at an important optical lithography production process] is accomplished. The resolution of the projection optics carried in the aligner is expressed with the relation of R=kxlambda/NA as the formula of Rayleigh is sufficient and it is known. Here, the resolution of projection optics and lambda of R are constants as which the wavelength of the light for exposure and NA are determined by the numerical aperture of projection optics besides the resolution of a resist, and k is determined according to a process.
[0003] In order to realize required resolution in projection optics corresponding to high integration of a semiconductor device, as shown in a top type, the efforts to the so-called raise in NA which enlarges numerical aperture of short-wavelength-izing of the light source for exposure or projection optics are continued. According to the aligner which makes argon fluoride excimer laser (ArF excimer laser) with the output wavelength of 193nm the light source for exposure, in recent years, micro processing which reaches to 0.18 micrometers - 0.13 micrometers becomes possible.
[0004] In the wavelength region of the output wavelength (193nm) of this argon fluoride excimer laser, since the material usable as a lens is limited to two, synthetic quartz glass and a calcium fluoride (fluorite), at the present stage from a viewpoint of permeability, sufficient permeability and development of the material which has internal homogeneity are succeedingly performed energetically as an optical material for this kind of aligners. With synthetic quartz glass, internal transmittance has reached even the level which can disregard internal absorption with the calcium fluoride more than 0.995-/cm.
[0005] The material for antireflection films by which a coat is carried out on the surface of an optical material has also been realized to level called 0.005 or less in the loss in respect of [each] a lens.
[0006]
[Problem(s) to be Solved by the Invention] In the wavelength region of such an ArF excimer laser light, by moisture and the organic substance adhering to the surface of the optical element which constitutes the optical system in an aligner (an illumination-light study system, projection optics), and the permeability of optical system falling or irradiating a laser beam, the ** material itself which constitutes an optical element deteriorates, and there is a problem that the permeability of optical system falls. The former originates in the moisture generated from the gas in the space inserted into two or more optical elements or the wall of the lens-barrel supporting optical system and the organic substance adhering on the surface of optical system. On the other hand, the latter originates in the deterioration phenomenon which progresses to the ** material itself, while the laser beam is irradiated by ** material.
[0007] Drawing 13 shows the example of the time amount change property of the permeability of optical system. During the laser beam exposure, carrying out outgoing radiation of the pulse laser light continuously from a laser light source, the illuminance of the exposure light between a laser light source and a mask and the illuminance of the exposure light on a wafer are measured at intervals of a predetermined period, and the permeability of the optical system which is the ratio of both the illuminance is computed and expressed for every measurement time of day. If the permeability of optical system once decreases immediately after exposure initiation of a laser beam (it considers as the short term variability of permeability since it changes to short time amount among the whole permeability change), permeability rises gently after that and time amount passes to some extent so that drawing 13 may show, it will be in a saturation state (since it changes gradually over long time amount among the whole permeability change, it considers as the long term variability of permeability) mostly. Thus, what the permeability of optical system recovers with a long time constant after that to which the permeability of optical system falls to the inside of a short time after a laser beam is irradiated is based on deterioration of the ** material itself which constitutes optical system and a laser beam is irradiated is produced when the moisture and the organic substance adhering to the optical-system surface are gradually removed by the exposure of a laser beam from the optical-system surface. This phenomenon is known as optical washing.
[0008] When exposing a photosensitive substrate, in order to control the light exposure on a substrate, it is desirable to expose permeability fluctuation of optical system in the small condition. Then, although it is possible to carry out the predetermined time exposure of the laser beam for exposure before exposure initiation, and to make permeability into a saturation state mostly, if exposure actuation is started after an appropriate time, in addition to a throughput falling, the long duration oscillation of the laser will be carried out before exposure, and it leads to the fall of the endurance of a laser light source, and is not desirable.
[0009] The 1st purpose of this invention is offering the exposure method and aligner which enabled it to always make the illuminance of the exposure light on a photosensitive substrate (exposure object) into desired value irrespective of time amount change of the attenuation factor of the exposure light in optical system. The 2nd purpose of this invention is offering the manufacture method of the semiconductor device exposes a circuit pattern etc. to a semiconductor substrate and it was made to raise the yield, predicting time amount change of the attenuation factor of the exposure light in an illumination-light study system or projection optics.

[0010]
[Means for Solving the Problem] It matches with drawing 1 which shows a gestalt of 1 operation, and this invention is explained.
(1) Invention of claim 1 is applied to an exposure method which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And before imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **) 1st attenuation factor K(n-1) B of exposure light which passes optical system 23 is measured. After imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), 2nd attenuation factor K(n-1) A of exposure light which passes optical system 23 is measured. Before imprinting an image of a pattern to the 2nd different predetermined side (n sheet wafer 25) from the 1st predetermined side (n-1) (wafer 25 of eye **) The purpose mentioned above is attained by measuring the 3rd attenuation factor KnB of exposure light which passes optical system 23, and controlling light exposure of exposure light to the 2nd predetermined side (n sheet wafer 25) based on the 1st, 2nd, and 3rd attenuation factor.
(2) Invention of claim 2 is characterized by amending time amount change which predicted time amount change of the optical property of optical system 23 based on the 1st attenuation factor K(n-1) B and 2nd attenuation factor K(n-1) A, and was predicted based on the 3rd attenuation factor KnB in an exposure method according to claim 1.
(3) Invention of claim 3 is characterized by prediction of time amount change carrying out by carrying out approximation amendment of the 1st attenuation factor K(n-1) B and the 2nd attenuation factor K(n-1) A in an exposure method according to claim 2.
(4) amendment of time amount change which predicted invention of claim 4 in an exposure method according to claim 2 — difference of 2nd attenuation factor K(n-1) A and the 3rd attenuation factor KnB — it is characterized by amending deltad.
(5) It is characterized by invention of claim 5 having an illumination-light study system in which optical system 23 illuminates the mask 16 with which a pattern was formed in an exposure method according to claim 1, and the projection optics 23 which imprints an image of a pattern to the 1st or 2nd predetermined side.
(6) The 1st predetermined side (n-1) (wafer 25 of eye **) is characterized by for invention of claim 6 being the sensitization side of a substrate of eye ** (n-1) in an exposure method according to claim 1, and the 2nd predetermined side (n sheet wafer 25) being a sensitization side of the n-th substrate.
[0011] (7) Invention of claim 7 is applied to an exposure method which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And the 1st control method which predicts an attenuation factor of exposure light which passes optical system 23, and controls light exposure by exposure light to the predetermined side 25, And it has the 2nd control method which predicts a different attenuation factor of exposure light which passes optical system 23 from the 1st control method, and controls light exposure by exposure light to the predetermined side 25. The purpose mentioned above is attained by imprinting an image of a pattern on the predetermined side 25 at least by one control method of the 1st and 2nd control methods.
Invention of claim 8 is set to an exposure method according to claim 7. (8) The 1st control method 1st attenuation factor K(n-1) B of exposure light which passes the optical system 23 before imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), 2nd attenuation factor K(n-1) A of exposure light which passes the optical system 23 after imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), Based on the 3rd attenuation factor KnB of exposure light which passes the optical system 23 before imprinting an image of a pattern to the 2nd different predetermined side (n sheet wafer 25) from the 1st predetermined side (n-1) (wafer 25 of eye **), light exposure of exposure light to the 2nd predetermined side (n sheet wafer 25) The attenuation factor KdmB of exposure light which passes the optical system 23 before it controls and the 2nd control method imprints an image of a pattern to the 3rd predetermined side (m sheet wafer 25) It is characterized by being what controls light exposure of exposure light to the 3rd predetermined side (m sheet wafer 25) based on the attenuation factor KdmA of exposure light which passes the optical system 23 after carrying out the predetermined time exposure of the exposure light at optical system 23.
(9) Invention of claim 9 is characterized by for the 2nd control method measuring an attenuation factor of exposure light which passes optical system 23, and controlling light exposure based on an attenuation factor exposure before of predetermined time, after an exposure, and under exposure during an exposure of predetermined time over optical system 23, in an exposure method according to claim 8.
(10) Invention of claim 10 is characterized by the 2nd control method changing predetermined time according to the mask 16 with which a pattern was formed in an exposure method according to claim 8.
(11) It is applied after, as for invention of claim 11, an aligner starts exposure actuation in an exposure method according to claim 9, as for the 2nd control method until it carries out predetermined time progress, and it is characterized by applying it, after the 1st control method carries out predetermined time progress.
(12) Invention of claim 12 is characterized by applying the 2nd control method, when being started after exposure actuation carries out a predetermined time halt in an exposure method according to claim 9.
Invention of claim 13 is set to an exposure method according to claim 8. (13) The 2nd control method Moving the mask 16 with which the electric eye 28 which receives exposure light has been arranged, and a pattern was formed on the predetermined side 25 and an abbreviation same side in the predetermined direction It is characterized by receiving exposure light and controlling light exposure by exposure light to the predetermined side 25 top by electric eye 28 based on a light-receiving result of the electric eye 28 before migration of a mask 16, and a light-receiving result of the electric eye 28 under migration of a mask 16 or after migration through optical system 23.
(14) It is characterized by invention of claim 14 corresponding to time amount to which predetermined time exposes at least one shot field of the photosensitive substrate 25 in an exposure method according to claim 8.
[0012] (15) Invention of claim 15 is applied to an exposure method which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And before imprinting an image of a pattern to the predetermined side 25, the purpose mentioned above is attained by carrying out the predetermined time exposure of the exposure light at optical system 23, moving the mask 16 with which a pattern was formed in the predetermined direction, and controlling light exposure based on an attenuation factor of exposure light which passes the optical system 23 before an exposure of predetermined time, and after an exposure.
(16) Invention of claim 16 is applied to an exposure method which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And, moving the mask 16 with which the electric eye 28 which receives exposure light has been arranged, and a pattern was formed on the predetermined side 25 and an abbreviation same side in the predetermined direction A light-receiving result of the electric eye [receive exposure light by

electric eye 28 through optical system 23, and] 28 before migration of a mask 16, Based on a light-receiving result of the electric eye 28 under migration of a mask 16 or after migration, the purpose mentioned above is attained by controlling light exposure by exposure light to the predetermined side 25 top. (17) Invention of claim 17 is applied to an exposure method which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And the purpose mentioned above is attained by receiving to coincidence exposure light which passed through the outside of the optical axis AX of optical system 23, and a shaft by light sensing portion 28, respectively, measuring an attenuation factor of exposure light which passes optical system 23 based on a light-receiving result of a light sensing portion 28, and controlling light exposure according to an attenuation factor of exposure light which passes optical system 23.
(18) Invention of claim 18 is equipped with the optical system 23 which projects an image of a pattern illuminated with exposure light from the light source 1 for exposure on the photosensitive substrate 25, when plurality differs, it measures an attenuation factor of exposure light which passes optical system 23, and it is applied to an exposure method which controls light exposure on a substrate 25 based on attenuation factor data of these plurality. And the 1st light-receiving method which receives exposure light which passes the optical axis AX of optical system 23, And either of the 2nd light-receiving method which receives exposure light which passes through the outside of the optical axis AX of optical system 23 and a shaft is chosen. The purpose mentioned above is attained by measuring an attenuation factor of exposure light which passes optical system 23 based on a light-receiving result by this selected light-receiving method, and controlling light exposure according to an attenuation factor of exposure light which passes optical system 23.
[0013] (19) Invention of claim 19 is applied to an aligner which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And 1st attenuation factor K(n-1) B of exposure light which passes the optical system 23 before imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), 2nd attenuation factor K(n-1) A of exposure light which passes the optical system 23 after imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), Measurement means 10 and 28 to measure the 3rd attenuation factor KnB of exposure light which passes the optical system 23 before imprinting an image of a pattern to the 2nd different predetermined side (n sheet wafer 25) from the 1st predetermined side (n-1) (wafer 25 of eye **), The purpose mentioned above is attained by having the control means 40 which controls light exposure of exposure light to the 2nd predetermined side (n sheet wafer 25) based on the 1st, 2nd, and 3rd attenuation factor.
(20) Invention of claim 20 is applied to an aligner which imprints an image of a pattern illuminated with exposure light on the predetermined side 25 through the optical system 23 arranged in an optical path of exposure light. And the 1st prediction method which predicts an attenuation factor of exposure light which passes optical system 23, And a prediction means 40 to predict an attenuation factor of exposure light which passes optical system 23 by either at least among the 2nd prediction method which predicts a different attenuation factor of exposure light which passes optical system 23 from the 1st prediction method, The purpose mentioned above is attained by controlling light exposure by exposure light to the predetermined side 25 based on an attenuation factor of the optical system 23 predicted by the prediction means 40, and having the control means 40 which imprints an image of a pattern on the predetermined side 25.
(21) Invention of claim 21 is applied to a method of manufacturing a semiconductor device with an aligner which imprints an image of a pattern illuminated with exposure light on the predetermined side 25, through the optical system 23 arranged in an optical path of exposure light. And before imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **) 1st attenuation factor K(n-1) B of exposure light which passes optical system 23 is measured. After imprinting an image of a pattern to the 1st predetermined side (n-1) (wafer 25 of eye **), 2nd attenuation factor K(n-1) A of exposure light which passes optical system 23 is measured. Before imprinting an image of a pattern to the 2nd different predetermined side (n sheet wafer 25) from the 1st predetermined side (n-1) (wafer 25 of eye **) The purpose mentioned above is attained by measuring the 3rd attenuation factor KnB of exposure light which passes optical system 23, controlling light exposure of exposure light to the 2nd predetermined side (n sheet wafer 25) based on the 1st, 2nd, and 3rd attenuation factor, and imprinting and manufacturing an image of a pattern on the predetermined side 25.
(22) invention of claim 22 is boiled and applied to a method of manufacturing a semiconductor device, through the optical system 23 arranged in an optical path of exposure light with an aligner which imprints an image of a pattern illuminated with exposure light on the predetermined side 25. And the 1st control method which predicts an attenuation factor of exposure light which passes optical system 23, and controls light exposure by exposure light to the predetermined side 25, And it has the 2nd control method which predicts an attenuation factor of exposure light which passes optical system 23 unlike the 1st control method, and controls light exposure by exposure light to the predetermined side 25. The purpose mentioned above is attained by imprinting an image of a pattern on the predetermined side 25 at least by one control method of the 1st and 2nd control methods, and manufacturing.
[0014] In addition, although drawing of a gestalt of operation was used by term of above-mentioned The means for solving a technical problem explaining a configuration of this invention in order to make this invention intelligible, thereby, this invention is not limited to a gestalt of operation.
[0015]
[Embodiment of the Invention] - Explain the gestalt of operation by this invention below gestalt - of the first operation, referring to a drawing. Drawing 1 shows the rough configuration of the aligner by the gestalt of operation of the first of this invention. As shown in drawing 1 , outgoing radiation of the laser beam as the parallel flux of light is mostly carried out from the ArF excimer laser 1 which oscillates pulsed light with the output wavelength of 193nm, and it is led to the light transmission aperture 3 by the side of the main part of an aligner through a shutter 2. Thereby, a shutter 2 stabilizes closing and the beam property which the light source 1 carries out a self-oscillation, and contains at least one of the main wavelength of pulsed light, wavelength width of face, and the reinforcement for an illumination-light way during exchange of a wafer or a reticle (accommodation).
[0016] Here, the main part of an aligner is held in the chamber 100, and it is controlled so that temperature is kept constant. It is orthopedically operated by the laser beam of a predetermined cross-section configuration by the beam plastic surgery optical system 4, and one of two or more of the ND filters with which attenuation factors (rate of extinction) differ mutually prepared in the turret board TP (drawing 1 ND1) is passed, it reflects by the reflective mirror 5, and the laser beam which passed the light transmission aperture 3 is led to the fly eye lens 6 as an optical integrator. Many lens elements are bundled, the fly eye lens 6 is constituted, and the light source image (secondary light source) of a large number corresponding to the number of the lens elements which constitute it is formed in the injection side side of this lens element.
[0017] With the gestalt of this operation, the turret board TP holds six ND filters ND1-ND6 (only ND1 and ND2 are illustrated), and six ND filters are arranged in an illumination-light study system exchangeable by rotating the turret board TP by the motor MT 1,

respectively. Here, six ND filters are determined by dispersion of the sensitivity of the resist on a wafer 25, and the oscillation reinforcement of the light source 1, the control precision of the exposure douse on a wafer 25, etc., and are suitably chosen according to the number of the pulsed light which should irradiate one on a wafer 25 (exposure pulse number) during scan exposure.
[0018] In addition, two plates which have two or more slits, respectively may be arranged face to face instead of the turret board TP in drawing 1 , the two plates may be displaced relatively in the array direction of a slit, and the reinforcement of pulsed light may be adjusted.
[0019] Moreover, the light source control circuit 45 adjusts the applied voltage (charge voltage) to the light source 1, and the light source 1 adjusts the reinforcement of the pulsed light injected from the light source 1 while oscillating pulsed light according to the trigger pulse sent out from the light source control circuit 45 (refer to drawing 6). In addition, about the light source control circuit 45, it mentions later.
[0020] With the gestalt of this operation, at least one side of adjustment of the oscillation reinforcement of the light source 1 by the light source control circuit 45 and adjustment of the permeability (attenuation factor) of pulsed light with the turret board TP can adjust now the reinforcement of the pulsed light on a reticle 16 25, i.e., a wafer.
[0021] Moreover, with the gestalt of this operation, while carrying out the synchronized drive of a reticle 16 and the wafer 25 and exposing the wafer 25 by the image of the pattern of a reticle 16, a mirror 5 is rotated by the motor MT 2 (vibration). Therefore, interference fringes, such as a speckle, move during scan exposure in the lighting field on the reticle 16 specified by the adjustable field diaphragm 12, and, thereby, the homogeneity of the addition quantity of light distribution of the pulsed light on a wafer 25 is carried out mostly.
[0022] in addition -- although one fly eye lens 6 is formed in this example -- between the reflective mirror 5 and the turret boards TP -- the -- the fly eye lens as a 2 optical integrator may be prepared, and the optical member of the shape of a rod of an internal reflection mold may be further used as an optical integrator instead of a fly eye lens.
[0023] Moreover, although mentioned later, in the location in which the secondary light source of a large number formed of the fly eye lens 6 is formed, the turret board 7 with which two or more aperture diaphragms 7a-7h from which at least one side of a configuration and magnitude differs mutually are formed is arranged. A rotation drive is carried out by the motor 8, one aperture diaphragm is chosen according to the pattern of the reticle 16 which should be imprinted on a wafer 25, and this turret board 7 is inserted into the optical path of an illumination-light study system. in addition, the turret board 7 and a motor 8 -- an illumination system -- business -- adjustable aperture-diaphragm equipment is constituted.
[0024] Two or more aperture diaphragms 7a-7h shown in drawing 2 are formed, it has responded to the use, and shifts to the turret board 7, and that aperture diaphragm is chosen as it so that it may mention later. As shown in drawing 2 , eight aperture diaphragms 7a-7h are formed in the turret board 7 which consists of transparence substrates, such as a quartz. Five aperture diaphragms 7a, 7e-7h with a circular opening are for changing a sigma value positively, three of the aperture diaphragms [them] 7e, 7f, and 7g are drawing used at the time of actual exposure actuation, and the two remaining aperture diaphragms 7a and 7h are aperture diaphragms used at the time of optical washing actuation. As mentioned above, by irradiating laser, optical washing makes pollutants adhering to the lens surface, such as moisture and an organic substance, exfoliate from the lens surface, and raises permeability.
[0025] Moreover, the aperture diaphragms 7b-7d with three deformation openings are for raising the resolution (depth of focus) of projection optics 23 by using at the time of exposure actuation. Aperture diaphragms 7c and 7d are drawing with the zona-orbicularis opening from which a zona-orbicularis ratio (ratio of the bore and outer diameter of a zona-orbicularis opening) differs mutually, and in order that the remaining one aperture-diaphragm 7b may form the four secondary light sources which carried out eccentricity, they are drawing with four openings which carried out eccentricity.
[0026] The turret board 7 with eight aperture diaphragms 7a-7h rotates through the motor 8 shown in drawing 1 , and one of eight aperture diaphragms, i.e., drawing which has a desired opening configuration, approaches the injection side of the fly eye lens 6, and it is arranged. If it puts in another way, it will be set as the injection side focal plane in which the secondary light source is formed of the fly eye lens 6. The drive of this motor 8 is controlled by the control circuit 40.
[0027] The flux of light from the secondary light source of a large number formed of the fly eye lens 6 passes the adjustable aperture diaphragm of the turret board 7, and branches to two optical paths by the beam splitter 9, the reflected light is led to the integrator sensor (photodetector) 10, and the illuminance (reinforcement) of the illumination light is detected. The signal according to the detected illuminance is inputted into a control circuit 40. On the other hand, the transmitted light is condensed by the capacitor optical system 15 which consists of refractility optical elements, such as two or more lenses, after being reflected by the reflective mirror 14 through a relay lens 11, the adjustable field diaphragm 12 which specifies a rectangular opening, and a relay lens 13. Thereby, homogeneity lighting of the lighting field on the reticle 16 specified by the opening of the adjustable field diaphragm 12 is mostly carried out in superposition. And the image of the circuit pattern on a reticle 16 is formed on a wafer 25, the resist applied on the wafer 25 exposes, and a circuit pattern image is imprinted by projection optics 23 on a wafer 25.
[0028] In addition, the lighting field on the reticle 16 specified by the adjustable field diaphragm 12 has the width of face of the scanning direction of a reticle 16 narrower than a pattern space, and the width of face of the direction which intersects perpendicularly with the scanning direction is larger than a pattern space. Furthermore, the lighting field has extended along with the diameter in the circular image field of projection optics 23 centering on the optical axis AX of projection optics 23.
[0029] Moreover, the configuration and magnitude of a rectangle opening of the adjustable field diaphragm 12 can be changed now by moving at least one blade which constitutes the adjustable field diaphragm 12 by the motor MT 3. If the width of face of the direction of a short hand of the rectangle opening is changed especially, the width of face of the scanning direction of the lighting field on a reticle 16 will change, and it will become possible to adjust the addition quantity of light (exposure douse) of two or more pulsed light irradiated by scan exposure by this by one on a wafer 25.
[0030] It is possible to adjust the addition quantity of light of two or more pulsed light which the oscillation frequency of the light source 1 can be changed into here by the trigger pulse sent out from the light source control circuit 45 with the gestalt of this operation as mentioned above, and is irradiated during scan exposure by this by one on a wafer 25. Furthermore, the addition quantity of light of two or more pulsed light irradiated by one on a wafer 25 can be adjusted during scan exposure also by changing the scan speed of a wafer 25 (and reticle 16).
[0031] Now, in a scan mold aligner, at least the reinforcement of the pulsed light on a wafer 25 and a number of pulsed light of one side which are irradiated during scan exposure by each point on a wafer 25, respectively is adjusted. The addition quantity of light (light exposure) of two or more pulsed light irradiated by each point in the field on the wafer 25 exposed by the pattern image of a reticle 16 by this, respectively is controlled to the proper value according to the sensitivity of the photoresist on a wafer 25.
[0032] Moreover, it can replace with optimization of the light exposure by accommodation of such pulsed light reinforcement, and

light exposure can be optimized by adjusting the number of the pulsed light irradiated by each point on a wafer 25, respectively. The number of the pulsed light irradiated by each point on a wafer 25, respectively can be adjusted by being able to change now the aperture width of the adjustable field diaphragm 12 mentioned above, i.e., the width of face of the scanning direction of the pulsed light (it corresponds to the above-mentioned projection field) on a wafer 25, the oscillation frequency of the light source 1, and the scan speed of a wafer 25, respectively, and changing at least one of the width of face of the pulsed light, oscillation frequency, and the scan speeds. Of course, optimization of light exposure can also be attained by adjusting the number of the pulsed light irradiated by the reinforcement of the pulsed light on a wafer 25, and each point on a wafer 25, respectively, respectively.

[0033] As mentioned above, at least one of the oscillation reinforcement of the light source 1, the permeability (rate of extinction) of pulsed light, the width of face of the pulsed light on a wafer 25, the oscillation frequency of the light source 1, and the scan speeds of a wafer 25 is adjusted, and the control precision of the proper value or its light exposure can be set up for the light exposure in each point on a wafer 25 in a precision prescribe (for example, **1 - 2%).

[0034] In addition, the projection optics 23 of this example consists of optical elements, such as a lens of refractility, altogether, and the aperture diaphragm Ep is arranged in the location of the pupil (entrance pupil) of projection optics 23. You may be the device in which that magnitude can be changed and the aperture diaphragm Ep within projection optics and the adjustable aperture diaphragms 7a-7h in an illumination-light study system are optically arranged in this case in a location [****] so that this aperture diaphragm Ep can change the numerical aperture of projection optics.

[0035] Maintenance immobilization of the reticle 16 is carried out by the reticle holder 17 in a reticle stage 18. The reticle stage 18 is established in the base 22 so that it may move two-dimensional along the inside of the field which intersects perpendicularly with the space of drawing 1 . A mirror 21 is installed in the reticle holder 17, the laser beam from a laser interferometer 20 is reflected by the mirror 21, incidence is carried out to a laser interferometer 20, and the location of a reticle stage 18 is measured by the laser interferometer 20. This positional information is inputted into a control circuit 40, and based on this positional information, a control circuit 40 drives the motor 19 for a reticle stage drive, and is controlling the location of a reticle 16, the speed of the reticle 16 under scan exposure, etc.

[0036] Maintenance immobilization of the wafer 25 is carried out by the wafer holder 26 on the wafer stage 27. The wafer stage 27 is formed so that it may move two-dimensional along the inside of the field which intersects perpendicularly with the space of drawing 1 . A mirror 31 is installed in the wafer stage 27, the laser beam from a laser interferometer 30 is reflected by the mirror 31, incidence is carried out to a laser interferometer 30, and the location of the wafer stage 27 is measured by the laser interferometer 30. This positional information is inputted into a control circuit 40, and based on this positional information, a control circuit 40 drives the motor 29 for a wafer stage drive, and is controlling the location of a wafer 25, the speed of the wafer 25 under scan, etc. The illuminance sensor (photodetector) 28 is formed on the wafer stage 27, and the illuminance of the exposure light irradiated by the wafer 25 is detected. The illuminance sensor 28 moves in the wafer stage 27 top, and the illuminance in the optical axis AX of projection optics 23 is detected. The detecting signal of this illuminance sensor 28 is inputted into a control circuit 40.

[0037] In the aligner by the gestalt of this operation, an illumination-light study system is arranged into inert gas ambient atmospheres, such as nitrogen gas. therefore — for example, the inert gas feeder which supplies inert gas to the case of the illumination-light study system which is not a drawing example, and the inert gas exhaust which discharges the inert gas polluted from the case are prepared as indicated by JP,6-260385,A. Moreover, inert gas, such as nitrogen gas, is supplied also to two or more space formed among two or more optical members which constitute projection optics 23, and the polluted inert gas is discharged from two or more space. Therefore, a gas transfer unit 41 supplies inert gas, such as nitrogen dried inside projection optics 23 through the pipe 43, by forming the inert gas feeder 41 and the inert gas exhaust 42, and the exhaust 42 discharges the gas inside projection optics 23 to the exterior through a pipe 44. In addition, it is also possible to use gases, such as helium and an argon, without restricting to nitrogen as inert gas.

[0038] Next, actuation of the aligner by the gestalt of this operation is explained. First, as shown in drawing 1 , after supplying inert gas, such as dry nitrogen, to the interior of projection optics 23 through a pipe 43 from a gas transfer unit 41 and filling up completely, the gas inside projection optics 23 is discharged to the exterior through a pipe 44 with the exhaust 42. The whole optical path of the exposure light of an illumination-light study system is also made into sealing structure like projection optics 23, and while carrying out supply restoration of the inert gas, such as nitrogen dried similarly, an internal gas is discharged with the exhaust.

[0039] In addition, it is desirable also during exposure to always operate a gas transfer unit 41 and the exhaust 42, and to hold the ambient atmosphere between optical elements, such as a lens room, in the condition that desiccation clarification was always carried out. The same is said of an illumination-light study system.

[0040] Subsequently, the reticle 16 by which the pattern used as the purpose of an imprint was drawn is conveyed and laid on a reticle stage 18 according to the reticle loading device in which it does not illustrate. At this time, the location of that reticle 16 is measured by the non-illustrated reticle alignment system, and the location of a reticle 16 is set as a position by the non-illustrated reticle positioning control circuit according to that result so that that reticle 16 may be installed in a position.

[0041] Here, the ** material of the optical system in the gestalt of this operation is explained. Although the gestalt of this operation explains the ArF laser beam to the example, the ** material in which wavelength has practically sufficient permeability to the light to about 160nm in the vacuum-ultraviolet region containing this ArF laser beam is restricted to synthetic quartz (SiO_2), the synthetic quartz which doped the fluorine, fluorite, etc. Generally, since fluorite is expensive, most ** material of the dioptrics member of the illumination-light study system of this example and projection optics 23 is formed from synthetic quartz. However, synthetic quartz has the orientation for permeability to decrease reversibly by the solarization, when ultraviolet pulsed light is continued and irradiated. This solarization is a phenomenon which permeability increases (permeability is recovered), when permeability will decrease if ultraviolet pulsed light is irradiated at synthetic quartz, and the exposure of ultraviolet pulsed light is suspended conversely.

[0042] Here, the synthetic quartz used for a projection aligner is explained to details. Generally as an optical member of the projection aligner which makes an ArF excimer laser the exposure light source, the single crystal of fluorides, such as synthetic quartz and a calcium fluoride (CaF_2), is used. Since the image formation optical system of a projection aligner consists of diameters of macrostomia of phi200 mmxt20mm using many thick lenses (optical member), the optical path length becomes very long. Therefore, what the permeability of the optical member of each [raise / (the attenuation factor of exposure light is made low) / the permeability in the whole optical system] is raised for (the attenuation factor of exposure light is made low) is required.

[0043] If an optical member with low permeability is used, when the temperature of an optical member rises, the ununiformity of a refractive index arises in an optical member or the surface deforms into it by the local thermal expansion of an optical member further, the fall of optical-character ability will arise by absorbing exposure light. As an optical member, 99.5%/cm or more of things

has desirable internal transmittance. Moreover, since the image formation engine performance (resolution) will fall if the ununiformity of refractive-index distribution and distortion (birefringence) are in an optical member, it is desirable for homogeneous deltan of refractive-index distribution to be 4x10 to six or less, and for distortion to be 4 or less nm/cm.

[0044] Since an ArF excimer laser is the pulse laser of high energy, even if it is synthetic quartz which has a stable property compared with other optical members, change of the permeability and structure accompanying a defect being generated by the exposure of ArF excimer laser light in a crystal and the so-called laser damage happen. As synthetic quartz with few such laser damages, a three or more 2x1017 molecules/cm thing is used [OH radical concentration] for 800-1000 ppm and hydrogen content child concentration. Doping a fluorine or hydrogen is also performed as a method of raising the endurance over the laser beam of synthetic quartz.

[0045] Although the optical thin film of various configurations is formed in it in order to make a desired optical property hold in the optical member of a projection aligner, a pile material, i.e., the material which has high, penetrable and high endurance to ArF excimer laser light, is used for a lifting in substrate side change, film destruction, etc. by the quantity of light loss by the ArF excimer laser absorption of light these film material of whose is also exposure light, and absorption pyrexia. It may bloom cloudy gradually by the chemical reaction by ultraviolet pulsed light etc. on the surfaces (mirror etc.) of dioptrics members (lens etc.) and reflected light faculty material, material may adhere on them, and permeability and a reflection factor may be changed. This cloudy material may be removable with optical washing which makes the output of a laser beam larger than usual, and irradiates ultraviolet pulsed light. However, with the gestalt of this operation, since the desiccation nitrogen gas which removed the impurity is supplied to the interior of an illumination-light study system and projection optics 23, fluctuation of the permeability by such cloudy material or a reflection factor is suppressed very small. In this invention, it considers as an attenuation factor including fluctuation of these permeability or a reflection factor.

[0046] Since there is quite more number of sheets of a dioptrics member among projection optics 23, most amounts of fluctuation of the permeability of the exposure light on the optical path from a half mirror 9 to a wafer 25 are regarded [be / it / under / illumination-light study system / comparing] as a part for the permeability fluctuation by projection optics 23. Then, how to prevent the precision fall of the light exposure control by permeability fluctuation of the projection optics 23 produced by the exposure of ultraviolet pulsed light below is explained.

[0047] - Perform a dummy exposure and compute the permeability of the exposure light which passes projection optics 23, before starting the control-exposure production process of performing a dummy exposure. If a laser beam is irradiated to optical system as it mentioned above, when the need for a dummy exposure was explained, the permeability of optical system will once decrease. Especially, permeability changes a lot at the time of exposure of [immediately after exposure initiation (for example, the 1-2nd wafers)]. Therefore, when exposing to the sensitization substrate of the 1-2nd sheet, in order that the permeability of projection optics 23 may decrease, light exposure cannot be controlled the optimal. Therefore, in order to perform exact light exposure control, it is necessary to predict reduction of the permeability of optical system.

[0048] In order to predict reduction in permeability, the illuminance sensor 28 is arranged on the optical axis AX of projection optics 23, a laser light source 1 is driven, and ****** of the pulse of a predetermined number, i.e., a dummy exposure, is performed. Let a pulse number be the value beforehand set to a predetermined number according to the exposure power per unit area of the field where a laser beam is irradiated here. For example, if the case where light exposure is 5 (mJ/cm2) is taken for an example, let pulse numbers required to expose one shot be 100 pulses. Since a laser light source 1 emits light at a fixed gap according to the set-up luminescence pulse number (shots per hour), if a shots per hour is set up, the time amount which luminescence takes will also become settled. In addition, the luminescence pulse number required for a dummy exposure per shot and a shots per hour (total luminescence pulse number) required for a dummy exposure can be set as arbitration. For example, the dummy exposure for three shots may be performed.

[0049] The permeability of projection optics 23 is measured in advance of a dummy exposure. Synchronizing with 1 time of the pulse which emits light to permeability measurement, the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28, respectively. Ratio LW/LI of the output LI of the integrator sensor 10 at this time and the output LW of the illuminance sensor 28 is computed. This is permeability Kd1B at the time of initiation of the exposure production process in drawing 3 (the time before the dummy exposure before the exposure to the 1st wafer: td1B). In addition, it is 1-(permeability) = (attenuation factor). In drawing 3 , a horizontal axis shows the exposure time and an axis of ordinate shows permeability. Subsequently, one shot = 100 pulse luminescence (dummy exposure) is performed. Synchronizing with 1 time of the pulse which emits light to permeability measurement, the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28 after a dummy exposure, respectively. Ratio LW/LI of the output LI of the integrator sensor 10 at this time and the output LW of the illuminance sensor 28 is computed. The time after the dummy exposure before the exposure to the 1st wafer [in / in this / drawing 3]: It is permeability Kd1A in Td1A. A reticle 16 is moved, while locating the illuminance sensor 28 on the optical axis of projection optics 23 and stopping the wafer stage 27, in case a dummy exposure is performed. That is, a reticle stage 18 performs the same actuation as the time of exposure of a scan mold.

[0050] As mentioned above, the permeability of the optical system to measure falls and it is set to permeability Kd1 B>Kd1A from the ** material itself which constitutes optical system by dummy exposure deteriorating. The permeability time amount change prediction property C1 of having connected these two permeability Kd1B and Kd1A in a straight line is computed by the degree type (1).

[Equation 1]

C1=(Kd1A-Kd1B) andX/1stS+Kd1A (1), however X: They are an exposure pulse number at the time of wafer exposure, and the exposure pulse number of the dummy exposure before the exposure to a 1stS:1 sheet wafer.

[0051] Subsequently, it moves on the wafer stage 27, the 1st wafer 25 is moved to an exposure starting position, and the exposure production process which exposes the circuit pattern on a reticle 16 to a wafer 25 is started. That is, the pattern of a reticle 16 is imprinted by the 1st wafer 25, controlling the luminescence reinforcement of a laser beam using the prediction property C1 so that the exposure power irradiated on a wafer 25 becomes fixed. After the exposure to the 1st wafer 25 is completed, it moves on the wafer stage 27 and the illuminance sensor 28 is again located on the optical axis AX of projection optics 23. Synchronizing with 1 time of the pulse which emits light to permeability measurement, the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28, respectively. Ratio LW/LI of the output LI of the integrator sensor 10 at this time and the output LW of the illuminance sensor 28 is computed. The time after the exposure to the 1st wafer [in / in this / drawing 3]: It is permeability K1A in T1A.

[0052] A wafer 25 is exchanged for the 2nd wafer 25, and alignment of a wafer 25 is performed. Subsequently, the wafer stage 27 is

driven, the illuminance sensor 28 is moved onto the optical axis AX of projection optics 23, and a dummy exposure is performed in advance of the exposure to the 2nd wafer 25. Synchronizing with 1 time of the pulse which emits light in advance of a dummy exposure, the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28 like the dummy exposure before exposing the 1st wafer 25, respectively. Calculation of ratio LW/LI of the output LI of the integrator sensor 10 at this time and the output LW of the illuminance sensor 28 calculates permeability Kd2B of :td2B at the time before the dummy exposure before the exposure to the 2nd wafer 25. Subsequently, pulse luminescence for one shot is performed, for example, and the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28 synchronizing with 1 time of the pulse which emits light to permeability measurement further, respectively. Calculation of ratio LW/LI of the output LI of the integrator sensor 10 and the output LW of the illuminance sensor 28 asks for permeability Kd2A in :Td2A at the time after the dummy exposure before the exposure to the 2nd sheet wafer 25. Kd2A is connected to two obtained permeability Kd2Bs in a straight line, and the permeability time amount change prediction property C2 is computed by the degree type (2).
[Equation 2]
C2=(Kd2 A-Kd2B) andX/2stS+Kd2A It is the exposure pulse number of (2), however the dummy exposure before the exposure to a 2stS:2 sheet wafer.
[0053] Subsequently, it moves on the wafer stage 27 and is made to move to the exposure starting position of the 2nd wafer 25. And the exposure production process which exposes the circuit pattern on a reticle 16 to a wafer 25 is started. That is, the pattern of a reticle 16 is imprinted by the 2nd wafer 25, controlling the luminescence reinforcement of a laser beam using the prediction property C2 so that the exposure power by the laser light source 1 irradiated on a wafer 25 becomes fixed. After the exposure to the 2nd wafer 25 is completed, it moves on the wafer stage 27 and the illuminance sensor 28 is again located on the optical axis AX of projection optics 23. Synchronizing with 1 time of the pulse which emits light to permeability measurement, the illuminance of exposure light is incorporated by the integrator sensor 10 and the illuminance sensor 28, respectively. Ratio LW/LI of the output LI of the integrator sensor 10 at this time and the output LW of the illuminance sensor 28 is computed. The time after the exposure to the 2nd wafer [in / in this / drawing 3]: It is permeability K2A in T2A.
[0054] A wafer 25 is exchanged for the 3rd wafer 25. Then, the wafer stage 27 is driven, the illuminance sensor 28 is moved onto the optical axis AX of projection optics 23, and the dummy exposure before the exposure to the 3rd wafer 25 is performed. And the prediction property C3 is computed like the 1st sheet and the 2nd sheet, and the 3rd wafer 25 is exposed based on the computed prediction property C3. Thus, an aligner is started and the dummy exposure before the exposure to the m-th wafer 25 is performed [in predetermined time]. The formula in the case of computing the exposure permeability time amount prediction property Cm at the time of the exposure to this m-th wafer 25 is expressed with a degree type (3).
[Equation 3]
Cm= (KdmA-KdmB) and X/mstS+KdmA On the occasion of (3), i.e., exposure of a wafer 25 of the m-th sheet, a dummy exposure is performed in advance of the exposure to a wafer 25, and the light exposure of the m-th wafer 25 is controlled by the permeability time amount change prediction property computed from the permeability of the optical system measured before and after the dummy exposure. Such light exposure control is performed after an exposure production process is started, namely, until it goes through predetermined time from time [of 1st pulse luminescence before the dummy exposure before the exposure to the 1st wafer 25 being performed]:td1B. Time amount until the exposure processing to the 3rd wafer 25 ends this predetermined time is set up.
[0055] Drawing 4 is a flow chart which shows the procedure exposed by computing a permeability time amount change property, performing a dummy exposure. CPU of a control circuit 40 performs this one by one by the program loaded to the control circuit 40. The adjustable aperture diaphragm of an illumination-light study system, the class of reticle, the numerical aperture NA of projection optics, and a shots per hour are set up at step S1. Based on this, the rotation drive of the turret board 7 is carried out by the motor 8, the aperture diaphragm which forms the secondary light source which has the configuration and magnitude corresponding to the class is inserted in an illumination-light way, and the numerical aperture NA of projection optics 23 is adjusted by the aperture diaphragm Ep. Moreover, the set-up reticle 16 is conveyed from a reticle library, and is set to a reticle stage 18. A wafer 25 is conveyed according to the wafer loading device in which it does not illustrate, and is laid on the wafer stage 27. If a wafer 25 is laid on the wafer stage 27, on the wafer stage 27, alignment will be carried out and maintenance immobilization will be carried out. The resist which is sensitive material is beforehand applied to the wafer 25 on the surface on which the pattern of a reticle 16 is imprinted.
[0056] At step S2, the illuminance sensor 28 moves on the wafer stage 27 so that it may be located on the optical axis AX of projection optics 23. Moreover, the aperture for illuminance measurement which moved in the reticle stage 18 and was prepared on the reticle 16 mentioned later is united with a location [****] to the illuminance sensor 28 and projection optics 23. At step S3, a laser light source 1 is driven, outgoing radiation of the laser beam for permeability measurement is carried out, the illuminance LI of exposure light reflected from a mirror 9 by the integrator sensor 10 is detected, and the illuminance sensor 28 detects the illuminance LW of the exposure light on the wafer stage 27 (measurement before a dummy exposure). The ND filter which has the optimal permeability from the detection value of the illuminance LI by the integrator sensor 10 is determined. In step S4, storage conservation is carried out as a detection illuminance before carrying out the dummy exposure of the detection result of illuminances LI and LW. A dummy exposure is performed at step S5, and if judged with the dummy exposure of 100 pulses having been completed, it will progress to step S6. In addition, some patterns on a reticle 16 are alternatively illuminated by the adjustable field diaphragm (reticle blind) 12 at the time of a dummy exposure, and it is made it to carry out relative displacement to the lighting field to which a reticle 16 is specified by the reticle stage 18 by the adjustable field diaphragm 12. That is, a dummy exposure is performed, making a reticle 16 scan like the time of the scan mold imprint mentioned later.
[0057] In step S6, outgoing radiation of the laser beam is carried out to permeability measurement, the illuminance LI of exposure light reflected from a mirror 9 by the integrator sensor 10 is detected, and the illuminance sensor 28 detects the illuminance LW of the exposure light on the wafer stage 27 (measurement after a dummy exposure). When exposing one shot on a wafer from the detection value of the illuminance LI by the integrator sensor 10, the passing speed of a required pulse number and the reticle stage 18 according to this pulse number, and the wafer stage 27 is determined. At step S7, storage conservation is carried out as a detection illuminance after carrying out the dummy exposure of the detection result of illuminances LI and LW.
[0058] And in step S8, a permeability time amount change prediction property is computed based on the detection illuminance after carrying out a dummy exposure with the detection illuminance before carrying out a dummy exposure. the time before the dummy exposure before [as shown in drawing 3] the exposure to the 1st wafer 25 — the ratio of the detection illuminance of :td1B — the time after the dummy exposure before the exposure to permeability Kd1B by LW/LI, and the 1st wafer 25 — the ratio of the detection illuminance of :td1A — permeability Kd1A by LW/LI is computed. Subsequently, the straight line which connected such

point Kd1B and Kd1A is made into a prediction property. This permeability time amount change prediction property is memorized as a primary function. In addition, this primary function may not be memorized but the storage 57 later mentioned as a table of permeability to the exposure time may be made to memorize.
[0059] If such is carried out and the permeability time amount change prediction property C1 is determined, in step S9 of drawing 4 , the wafer stage 27 will move and the 1st wafer 25 will be moved to an exposure starting position. Then, a pattern is imprinted on a wafer 25. And some patterns on a reticle 16 are alternatively illuminated by the adjustable field diaphragm (reticle blind) 12. A reticle stage 18 is driven and relative displacement is carried out to the lighting field specified by the adjustable field diaphragm 12 from the location defined on the appearance criteria of a wafer 25 by making a reticle 16 into an exposure starting position. Synchronizing with migration of this reticle stage 18, relative displacement of the wafer 25 is carried out to that lighting field and a projection field [****] about projection optics 23 by the wafer stage 27. This imprint is the so-called scan type of imprint (a step and scanning method). In addition, the step-and-repeat method which bundles up the whole surface of the pattern space on a reticle 16 with the gestalt of this operation, and is imprinted on a wafer without scanning a reticle 16 may be used.
[0060] Drawing 5 is a block diagram which carries out feedback control of the reinforcement of the laser beam in this invention to the aim illuminance on a wafer, and each circuit including the light source control circuit 45 mentioned above can be prepared with the gestalt of software or hardware for example, in a control circuit 40. The aim illuminance on the wafer determined according to the sensitivity property of a resist etc. is set to the desired value setting circuit 51. If the control value over an aim illuminance is set with d (unit dgt), it can express with a degree type (4).
[Equation 4]
d=D/(a-Cm/Ka) (4) however D:setting light exposure (an unit is mJ/cm2), a:light-exposure conversion factor (an unit is mJ/cm2/dgt), the permeability time-amount change prediction property at the time of wafer exposure of the Cm:m sheets (prediction permeability), Ka: It is lens criteria permeability.
[0061] In drawing 5 , the integrator sensor 10 outputs the detecting signal LI according to the illuminance of the exposure light equalized by the fly eye lens 6, and the illuminance sensor 28 outputs the detecting signal LW according to the illuminance of the exposure light on the wafer stage 27 as mentioned above. Then, before starting an exposure activity, the illuminance sensor 28 is moved onto the optical axis AX of projection optics 23, and the measurement value LI of the integrator sensor 10 and the measurement value LW of the illuminance sensor 28 are held in a sample hold circuit 52.
[0062] Computing the ratio (output LI of output LW / sensor 10 of a sensor 28) of the detecting signal LI of the integrator sensor 10, and the detecting signal LW of the illuminance sensor 28 with a divider 53, the gain alpha computing element 54 multiplies LW/LI by the predetermined coefficient K1, and calculates Gain alpha. And during an exposure activity, Gain alpha can take advantaging of the output signal of the integrator sensor 10 with a multiplier 55, and the presumed real illuminance LPR is outputted. That is, the presumed real illuminance LPR multiplies the gain alpha by which the measurement value of the integrator sensor 10 multiplied by it and asked 50/100 of ratios for the predetermined coefficient K1 at the time of exposure initiation when [100 / the illuminance on a wafer] it was 50 by the output signal of the integrator sensor 10 under exposure, and presumes the illuminance on a wafer. That is, this gain alpha is set up as optimal value, when there shall be no fluctuation of permeability.
[0063] Gain beta can take further advantaging of the presumed real illuminance LPR by which Gain alpha was able to multiply the detecting signal of the integrator sensor 10 with the multiplier 55 with a multiplier 56, and the presumed real illuminance LPRC after the amendment on a wafer calculates. Gain beta is computed as follows. The permeability time amount change prediction property beforehand set to have mentioned above to storage 57 is memorized. a timer 58 -- the elapsed time from exposure initiation -- measuring -- the time check -- by time amount, storage 57 is accessed and permeability is read. The read result is inputted into the gain beta computing element 59, and the gain beta computing element 59 multiplies the permeability by which reading appearance was carried out by the predetermined coefficient K2, and calculates Gain beta. For example, when permeability is 80%, Gain beta is set as 0.8xK2.
[0064] Thus, the signal LPRC by which Gain alpha and beta was able to multiply the detecting signal of the integrator sensor 10 expresses the value which presumed the real illuminance on the wafer stage 27, and this signal is inputted into the deflection machine 60. The deflection machine 60 calculates the deflection of the aim illuminance on the wafer outputted from the desired value setting circuit 51, and the presumed real illuminance after amendment, inputs this deflection into the PID arithmetic circuit 61, performs a PID operation, sends that result of an operation to the light source control circuit 45, and controls the light source 1, namely, adjusts that oscillation reinforcement. Even when the permeability of optical system changes with the feedback control explained above after exposure initiation, the oscillation reinforcement of a laser light source 1 is adjusted so that it may become fixed without changing the presumed real illuminance LPRC on the wafer 25 by change of permeability.
[0065] supposing a pattern image is now projected on a wafer 25 between td1 A-t1A at the time of drawing 3 -- a time -- :td1 A-t1A -- the light exposure used during exposure of a between is computed from the prediction property C1 based on elapsed time (exposure time) in the meantime.
[0066] After the exposure to the 1st wafer 25 is completed by step S9 (time t1A of drawing 3) of drawing 4 , it sets to steps S10-S12. The laser beam for permeability measurement emits light like the above-mentioned step S2 - S4. The time after exposing to the 1st wafer 25: Compute illuminance ratio LW/LI detected by the integrator sensor 10 and the illuminance sensor 28 in t1A to permeability K1A, memorize this permeability K1A to storage 57, and progress to step S13. At the time of the illuminance detection by steps S10-S12, as shown in drawing 6 , the illuminance sensor 28 is moved to a location [****] to Aperture RA and projection optics 23 for measurement which were prepared in the outside of pattern space RP of a reticle 16, and the illuminance on the wafer stage 27 is measured.
[0067] In step S13, after processing by the flow chart of drawing 4 is started, it is judged whether predetermined time passed. When N judging is carried out at step S13, it progresses to step S14, and the 1st wafer 25 is exchanged for the following wafer 25, and it returns to step S2. On the other hand, when Y judging of is done at step S13, it progresses to the flow chart (drawing 8) of the control without a dummy exposure mentioned later.
[0068] After ending processing by the flow chart of drawing 4 , permeability K1A of the optical system measured in steps S10-S12 is measured in order to use it by the control without a dummy exposure mentioned later.
[0069] In the imprint of the pattern of the 2nd henceforth to a wafer 25, since a pattern exists at least on a wafer 25, it measures by the wafer alignment system whose mark attached to the pattern imprinted beforehand is not illustrated. That is, the location of the mark pattern on a wafer 25 is measured, and the location of a reticle stage 18 or the wafer stage 27 is controlled so that the pattern to be imprinted from now on becomes position relation to the pattern previously imprinted on the wafer 25 according to the result. In addition, the permeability time amount change prediction property shown in drawing 3 corresponds to the short term variability of

the permeability by deterioration of the ** material of the optical system of drawing 13 .
[0070] – If it is judged with predetermined time having passed after processing by the flow chart of drawing 4 is started when Y judging of is done in step S13 of control– drawing 4 without a dummy exposure namely, before starting the following exposure production process, the permeability time amount change prediction property (permeability time amount change property) of a penetrometer photometry system as shown with a sign E4 by drawing 7 will be computed. Drawing 7 extracts and expands the portion about the 3rd sheet and the 4th wafer among the properties of drawing 3 .
[0071] For example, permeability Kd3A [in / the time after the dummy exposure before the exposure to the 3rd wafer 25 / :td3A] when judged with the predetermined time mentioned above after the exposure processing to the 3rd wafer 25 having passed, The time after exposing the 3rd wafer 25: Compute the permeability time amount change prediction property D4 when asking for permeability K3A in t3A, connecting two permeability Kd3A and K3A which were obtained in a straight line, and exposing the 4th wafer 25.
[0072] In the case where a dummy exposure is performed, just before performing the exposure production process over the 1st sheet or the 2nd wafer 25, the dummy exposure for one shot was performed, and the permeability time amount change prediction property was computed from the permeability before and behind the dummy exposure. That is, since the permeability time amount change prediction property was searched for just before the exposure production process when the exposure production process over the 1st sheet or the 2nd wafer 25 was performed, swap time of a wafer 25 did not need to be taken into consideration. Moreover, since the exposure of exposure light was not performed to optical system while replacing with the exposure sensor 28 arranged on the optical axis of projection optics 23 at the time of a dummy exposure and moving on the optical axis of projection optics 23 in the exposure field of a wafer 25, change of the permeability of the ** material of the optical system produced in the meantime has been disregarded.
[0073] However, in the case where a dummy exposure is not performed, the permeability time amount change prediction property D4 when exposing the 4th wafer 25 cannot be used as it is, for example. That is, the time amount for performing wafer exchange to the 4th sheet and alignment of the 4th wafer 25 from the 3rd sheet is required. Therefore, while performing wafer exchange to the 4th sheet, and alignment from the 3rd sheet, the permeability of optical system may change (permeability is recovered). For this reason, when controlling the exposure power irradiated on the 4th wafer 25 using the computed prediction property D4, fluctuation of the permeability produced while carrying out alignment of the location of the 3rd wafer 25 to the exchange to the 4th wafer 25 and the 4th wafer 25 must be taken into consideration.
[0074] After exchanging for the 4th wafer 25 and performing alignment of a wafer 25, it moves on the wafer stage 27 and the illuminance sensor 28 is located on the optical axis AX of projection optics 23. Light is emitted in the laser beam for permeability measurement, and permeability K4B in :t4B is measured at the time before exposing the 4th wafer 25. prediction -- a property -- D -- four -- an inclination -- being the same -- prediction -- a property -- D -- four -- ' -- having mentioned above -- a time -- : -- t -- four -- B -- setting -- computing -- a time -- : -- t -- four -- B -- it can set -- permeability -- K -- four -- B -- and -- a time -- : -- t -- three -- A -- it can set -- permeability -- K -- three -- A -- a difference -- delta -- d34 is calculated. If permeability K4B is higher than permeability K3A, and permeability K4B is lower than permeability K3A upwards in prediction property D4', prediction property D4' will be amended according to a difference deltad34 downward, and the prediction property E4 will be computed by the degree type (5).
[Equation 5]
E4=(K3A-Kd3A) andX/3Sw+K4B They are (5), however an exposure exposure pulse number to a 3Sw:3 sheet wafer.
[0075] If the permeability time amount change prediction property E4 is computed, will drive the wafer stage 27, the predetermined field of the 4th wafer 25 will be made to counter projection optics 23, and exposure will be started. The pattern of a reticle 16 is imprinted by the 4th wafer 25, controlling using the prediction property E4 that the luminescence reinforcement of a laser beam was computed so that the exposure power by the laser light source 1 irradiated on a wafer 25 becomes fixed. After the exposure to the 4th wafer 25 is completed, you move on the wafer stage 27 and the illuminance sensor 28 makes it located on the optical axis AX of projection optics 23. Light is emitted in the laser beam for permeability measurement, and permeability K4A in :t4A is measured at the time after exposing the 4th wafer 25. Subsequently, exchange and after carrying out alignment, the illuminance sensor 28 is moved for a wafer 25 to the 5th wafer 25 onto the optical axis AX of projection optics 23, and light is emitted in the laser beam for permeability measurement, and permeability K5B in :t5B is measured at the time before exposing the 5th wafer 25. A time before and after exposing the 4th wafer 25 : t4B, permeability K4B in t4A, K4A, And the time before exposing the 5th wafer 25 : from permeability K5B in t5B The permeability time amount change prediction property E5 when exposing the 5th wafer 25 is computed by the degree type (6), and exposure to the 5th wafer 25 is performed like the exposure to the 4th wafer 25 mentioned above.
[Equation 6]
E5=(K4A-K4B) andX/4Sw+K5B (6)
However, it is an exposure exposure pulse number to a 4Sw:4 sheet wafer.
[0076] The formula in the case of computing the permeability time amount prediction property En when exposing the n-th wafer 25 is expressed with a degree type (7).
[Equation 7]
En= (K(n-1) A-K(n-1) B) and X/(n-1)Sw+KnB (7) -- however, K(n-1) A: (n-1) -- permeability [in / the time after exposing the wafer 25 of eye ** / t(n-1) A] -- K(n-1) B: (n-1) -- permeability [in / the time before exposing the wafer 25 of eye ** / t(n-1) B], and Sw(n-1): (n-1) -- it is the permeability in tnB at the time before exposing the exposure exposure pulse number to the wafer of eye **, and the KnB:n wafer 25.
[0077] Like the case of the control which performs a dummy exposure, synchronizing with a laser pulse, measurement of the permeability in control without a dummy exposure incorporates the illuminance of exposure light, respectively, and is performed by the integrator sensor 10 and the illuminance sensor 28 by computing ratio LW/LI of the output LI of the incorporated integrator sensor 10, and the output LW of the illuminance sensor 28.
[0078] Drawing 8 is a flow chart which shows the procedure exposed by computing a permeability time amount change property based on the permeability of the back before exposing the wafer 25 of eye ** (n-1), and the permeability before exposing U of the n-th sheet. It is carried out following the flow chart of the control which performs the dummy exposure of drawing 4 mentioned above. It is exchanged for the following wafer 25 at step S20, and alignment of a wafer 25 is performed. At step S21, the illuminance sensor 28 moves on the wafer stage 27 so that it may be located on the optical axis AX of projection optics 23. Moreover, it moves in a reticle stage 18 and the aperture RA for illuminance measurement prepared on the reticle 16 is united with a location [****] to the illuminance sensor 28 and projection optics 23. At step 22, a laser light source 1 is driven, outgoing radiation of the laser beam

for permeability measurement is carried out, the illuminance LI of exposure light reflected from a mirror 9 by the integrator sensor 10 is detected, and the illuminance sensor 28 detects the illuminance LW of the exposure light on the wafer stage 27 (measurement before exposure). The passing speed of the ND filter which has the optimal permeability from the detection value of the illuminance LI by the integrator sensor 10, a shots per hour, and a reticle stage 18 is determined. At step S23, storage conservation is carried out as a detection illuminance before exposing the detection result of illuminances LI and LW.

[0079] The detection illuminance before exposure of the wafer 25 of eye ** storage conservation is carried out in step S24 at storage 57 (n-1), and the detection illuminance after exposure, Based on the detection illuminance before exposure of the wafer 25 of eye (n) ** memorized at step S23, the permeability time amount change prediction property En at the time of the exposure to the n-th wafer 25 is computed, and this prediction property En is memorized as a primary function. The prediction property En may be memorized to storage 57 as a table of permeability to the exposure time.

[0080] If the prediction property En is memorized to storage 57, will progress to step S25, and drive the wafer stage 27, the predetermined field of the n-th wafer 25 is made to counter projection optics 23, and exposure is started. since the computed prediction property En is memorized by storage 57 — drawing 5 — setting — a timer 58 — the elapsed time from exposure initiation — measuring — the time check — by time amount, storage 57 is accessed and permeability is read. Inputted into the gain beta computing element 59 in the feedback control which mentioned the read result above, the gain beta computing element 59 multiplies the permeability by which reading appearance was carried out by the predetermined coefficient K2, and calculates Gain beta. A pattern is imprinted on the n-th wafer 25 by the above processing. Any of a step which was mentioned above, a scanning method, and a step-and-repeat method are sufficient as this imprint.

[0081] d (unit dgt) is expressed with a degree type (8) in the aim control value set as the desired value setting circuit 51 of drawing 5 .

[Equation 8]

d=D/(a-En/Ka) (8) however D:setting light exposure (an unit is mJ/cm2), a:light-exposure conversion factor (an unit is mJ/cm2/dgt), the permeability time-amount change prediction property at the time of wafer exposure of the En:n sheets (prediction permeability), Ka: It is lens criteria permeability.

[0082] Termination of the exposure to a wafer 25 moves on the wafer stage 27 so that the illuminance sensor 28 may be located on the optical axis AX of projection optics 23 in step S26. Moreover, a reticle stage 18 is moved and the aperture RA for illuminance measurement prepared on the reticle 16 is united with a location [****] to the illuminance sensor 28 and projection optics 23. The time after the laser beam for permeability measurement emitting light and exposing to a wafer 25 like the above-mentioned steps S22-S23 in steps S27-S28: Compute permeability KnA from illuminance ratio LW/LI detected by the integrator sensor 10 and the illuminance sensor 28 in tnA (measurement after exposure), memorize this permeability KnA, and progress to step S29.

[0083] In step S29, it is judged whether measurement was completed about all the wafers 25. When N judging is carried out at step S30, processing to return and the following wafer 25 is performed to step S20. On the other hand, when Y judging of is done at step S30, processing by the flow chart of drawing 8 is ended.

[0084] The feature of the gestalt of the first operation is summarized.

(1) Since a dummy exposure is performed before the exposure to the m-th wafer 25, the permeability time amount change prediction property Cm when exposing a wafer 25 is predicted from the permeability of the back before performing a dummy exposure and the addition light exposure to the 25th page top of a wafer was controlled When change of permeability is large (for example, inside of the predetermined time after starting the aligner which was carrying out a long duration halt) The error of the permeability predicted since the permeability at the time of exposure was predicted from change of the permeability by the dummy exposure performed just before exposure is suppressed, and the light exposure control with a more high precision is attained.

(2) (m+1) Henceforth [**] (like [after the predetermined time progress after starting an aligner]) Permeability K(n-1) A after exposure of as opposed to the wafer 25 of eye ** (n-1) for the permeability Dn predicted from the permeability of the back before exposing the wafer 25 of eye ** (n-1) when change of permeability decreased, The permeability time amount change prediction property En was computed by difference deltad with the permeability KnB before exposing the n-th wafer 25 after exchanging and carrying out alignment of the wafer having amended. Since the addition light exposure when exposing the n-th wafer 25 using this prediction property En was controlled, even when permeability changes into the time amount which exchange and the alignment activity of a wafer 25 take, the error of the predicted permeability is suppressed and the light exposure control with a more high precision is attained.

[0085] (3) Since the above (1) is controlled and after predetermined time progress was made to control the above (2) until predetermined time had passed since time [of 1st pulse luminescence being performed to the 1st wafer 25]:td1B The effect of suppressing the fall of a becoming [are carried out whenever a dummy exposure exchanges a wafer 25, and / the processing time / long] **** throughput, and deterioration of the optical system containing the laser light source by the count of luminescence increasing by dummy exposure is acquired.

(4) Since it was made to move a reticle stage 18 during a dummy exposure on the occasion of control of the above (1) and permeability fluctuation of the projection optics 23 when carrying out the dummy exposure can be brought close to permeability fluctuation of the projection optics 23 when exposing the wafer 25, it becomes possible to perform light exposure control with a more high precision.

[0086] Although considered as time amount until the exposure processing to the 3rd wafer 25 ends the predetermined time to which control which performs a dummy exposure is carried out from time [of 1st pulse luminescence before the dummy exposure before the exposure to the 1st wafer 25 being performed]:td1B in the above explanation, this predetermined time can be set as arbitration. For example, when the permeability change by the dummy exposure before performing the exposure production process over the 1st wafer 25 is smaller than a prospective permeability change, it may be made to perform light exposure control without a dummy exposure which does not perform the dummy exposure before an exposure production process to the wafer 25 after the 2nd sheet. moreover, permeability change when the permeability change by the dummy exposure before performing the exposure production process over the 3rd wafer 25 performs a dummy exposure to the 1st sheet and the 2nd wafer 25 and abbreviation — when the same, it may be made to perform light-exposure control which performs a dummy exposure before an exposure production process also to the 4th wafer 25, and performs a dummy exposure. Moreover, it is good also as control which performs a dummy exposure to all the wafers 25.

[0087] Furthermore, although it was made to clock from time [of 1st pulse luminescence before the dummy exposure before the exposure to the 1st wafer 25 being performed]:td1B, the above-mentioned predetermined time may be made to interrupt the exposure processing mentioned above on the way, and to be clocked from the time of exposure processing being resumed, when an

aligner is suspended for a long time than the time amount defined beforehand.
[0088] At the time of the illuminance detection in steps S10-S12, steps S21-S23, and steps S26-S28 which were mentioned above Although the illumination light passes the aperture RA for measurement prepared in the outside of pattern space RP of a reticle 16 as shown in drawing 6 and the illuminance on the wafer stage 27 by the illumination light was measured by the illuminance sensor 28 When the opening aperture for measurement is prepared on the reticle stage 18, you may make it detect the illuminance on the wafer stage 27, as the illumination light passes this opening aperture.
[0089] Moreover, although it was made to carry out feedback control so that the permeability time amount change prediction property Cm might be computed by connecting two permeability, the back before performing a dummy exposure, with the control which performs the dummy exposure mentioned above, respectively and laser beam reinforcement on a wafer 25 might be made into an aim illuminance using the prediction property Cm As permeability is measured also during a dummy exposure, before performing a dummy exposure, the permeability of three or more points after performing a dummy exposure may be used during a dummy exposure. Since the illuminance sensor 28 is arranged during the dummy exposure at the optical-axis top of projection optics, this is possible. The precision of a prediction property improves by using the permeability of three or more points. Not straight line approximation but the regression line and regression curve which do not connect the computed permeability directly are sufficient also as the approximation method. Which method may be used for polynomial approximation, power approximation, characteristic approximation, correction characteristic approximation, etc.
[0090] In order to measure permeability during a dummy exposure, if the output LI of the integrator sensor 10 and the output LW of the illuminance sensor 28 are incorporated in :td1M synchronizing with a luminescence pulse and illuminance ratio LW/LI is computed, permeability Kd1M in :td1M will be obtained the time of dummy being under exposure the time of being the middle of 100 pulse luminescence being performed by dummy exposure.
[0091] When the permeability at the time of exposure was predicted from the permeability, the back before performing a dummy exposure, of two points, straight line approximation was performing, but if permeability is measured also during a dummy exposure as mentioned above, it will also become possible to resemble a curve from the permeability of three or more points.
[0092] In addition, what is necessary is for the error of the permeability prediction property Cm by the top type (3) to be large, and just to increase the shots per hour at the time of a next dummy exposure, when the exposure quality after exposing a wafer 25 does not satisfy predetermined quality although the shots per hour at the time of a dummy exposure was made into one shot in the above-mentioned explanation.
[0093] Furthermore, although the above-mentioned explanation explained the light exposure control to which permeability falls in the time amount change property of the permeability of the projection optics 23 of drawing 13 , you may make it control light exposure only by control without a dummy exposure in the place which permeability recovers, without performing a dummy exposure.
[0094] - In the control which performs the gestalt-dummy exposure of the second operation, it may be made to carry out feedback control so that laser beam reinforcement on a wafer 25 may be made into an aim illuminance using the prediction property Fm computed by having multiplied by the predetermined coefficient to the permeability time amount change prediction property Cm computed by having connected two permeability, the back before performing a dummy exposure, respectively.
[0095] Drawing 9 extracts and expands the portion about the 1st wafer 25 among the graphs of drawing 3 . When exposure processing is started, a laser beam emits light and there is also no between, it is common for a time change of permeability to be large as the continuous line showed to drawing 9 . If the permeability at the time of the exposure to the 1st wafer 25 is predicted in the prediction property C1 computed by having connected two points of permeability Kd1A after performing permeability Kd1B before performing a dummy exposure, and a dummy exposure like the gestalt of the first operation, an error with change of the actual permeability which shows the prediction property C1 shown with a dashed line as a continuous line may become large. In this case, since permeability is predicted actually more small, it serves as fault exposure. Then, when the inclination of the prediction property C1 is larger than a predetermined value, the permeability prediction property F1 at the time of the exposure to the 1st wafer 25 is computed using the degree type (9) which multiplied the 1st term of a top type (1) by one or less coefficient k, and was obtained.
[Equation 9]
F1=(Kd1A-Kd1B) andX.k/1stS+Kd1A It is (9), however k<=1.
[0096] The value of a coefficient k is usually set to 1, and when the inclination expressed with the 1st term of a top type (9) becomes beyond a predetermined value, let it be a coefficient k= 0.8. If it does in this way, the permeability predicted by the prediction property F1 shown with an alternate long and short dash line will approach actual permeability compared with the case where it is predicted by the prediction property C1. If a top type (9) is rewritten about the prediction property Fm over the m-th wafer 25, it will become a degree type (10).
[Equation 10]
Fm= (KdmA-KdmB) and X-k/mstS+KdmA (10) [0097] The feature of the gestalt of the second operation is summarized. Since the permeability at the time of exposure was predicted to the inclination of the permeability time amount change prediction property Cm predicted from the permeability of the back before performing a dummy exposure in the permeability time amount change prediction property Fm which multiplied by one or less coefficient k Like immediately after starting the aligner under prolonged halt, even when it is large and change of permeability becomes [the inclination of a prediction property] large, the prediction property which stopped the inclination, without increasing the shots per hour at the time of a dummy exposure can be acquired. Consequently, the effect of suppressing deterioration of the optical system in which the number of dummy exposures contains the laser light source by the fall of the throughput by the increase or being carried out and the processing time becoming long and the increment in the count of luminescence is acquired. Of course, also with the gestalt of the second operation, approximation of two points may be performed by straight line approximation, and you may approximate with a curve.
[0098] - Gestalt of the third operation - With the gestalt of the third operation, an area sensor is used for the illuminance sensor 28, and the average illumination in the perimeter of the optical axis AX of projection optics 23 and an optical axis AX is detected. The permeability of a penetrometer photometry system serves as max with an optical axis AX, and if it separates out of a shaft, it will fall slightly. Therefore, it is only near the optical axis AX in a lighting field that light exposure is controlled as the set-up light exposure as a result of controlling light exposure by feedback control by drawing 5 , when the illuminance in the lighting field by exposure light was measured only by one in an optical axis AX. Drawing 10 is a graph showing the setting light exposure in the case of carrying out illuminance measurement by one in an optical axis AX, and performing light exposure control. A horizontal axis is the displacement from an optical axis AX, and an axis of ordinate is setting light exposure. In drawing 10 , the light exposure besides a shaft differs slightly in accordance with the light exposure set up in the optical axis AX compared with the set-up light exposure.

[0099] If light-receiving area constitutes the illuminance sensor 28 from a lighting field by projection optics 23 using a large area sensor, the illuminance sensor 28 will detect the average illumination of the illumination light by which incidence is carried out to a light-receiving side. Drawing 11 is a graph showing the light exposure at the time of measuring the average illumination of the lighting field which includes an optical axis AX using an area sensor. Although the light exposure in an optical axis AX differs from the set-up light exposure slightly since feedback control is carried out by average illumination, it is controlled to become the light exposure set up when averaging the lighting field.
[0100] The gestalt of the third operation is summarized. Since the average illumination in the lighting field by projection optics 23 is measured using an area sensor, the permeability time amount change property of permeability measurement optical system is computed from this average illumination and it was made to carry out feedback control of the light exposure at the time of exposure When permeability differs out of an optical axis AX and a shaft, it becomes possible to make small the gap of light exposure to the set-up light exposure by which feedback control was carried out compared with the time of measuring the illuminance in a lighting field by one on an optical axis AX, and carrying out feedback control of the light exposure. Consequently, the effect that the exposure quality by the aligner improves is acquired.
[0101] Instead of using an area sensor, the illuminance in the lighting field by projection optics 23 may be detected by two or more predetermined gap ****** in the perpendicular direction to an optical-axis AX top and the direction which scans the illumination light from an optical axis AX using the illuminance sensor 28 which detects the illuminance of one point used with the gestalt of the first and the second operation. Drawing 12 is a graph showing the light exposure in the case of measuring the illuminance in a lighting field at nine points including an optical axis AX, and performing light exposure control by the average of nine measurement values. The direction which goes in the inner part of a drawing in drawing 12 is a scanning direction. Although it differs from the light exposure to which the light exposure in an optical axis AX was set slightly like the case where an area sensor is used since feedback control of the light exposure is carried out by average illumination, it is controlled to become the light exposure set up when averaging the lighting field.
[0102] You may enable it to choose the light exposure control based on the illuminance detected in one on the optical axis AX in a lighting field which was explained above, and the light exposure control based on the average illumination in a lighting field. For example, what is necessary is just to choose the former light exposure control to control strictly the light exposure in certain one on a wafer 25 (specific 1 [i.e.,] in 1 chip field). Like ASIC, this becomes effective, when a circuit pattern is various. What is necessary is on the other hand, just to choose the latter light exposure control to stop the exposure nonuniformity on a wafer 25. This is effective when becoming a repeat pattern like DRAM. Thus, it is not necessary to become possible to perform optimal light exposure control according to the purpose, and to install an aligner for every semiconductor device to manufacture, and cost reduction becomes possible by one set of an aligner. Moreover, the effect that the exposure quality at the time of exposure improves is acquired.
[0103] Although the above explanation explained the aligner which used projection optics, this invention is applicable also to the proximity aligner which is made to stick a mask and a substrate, without using projection optics, and exposes the pattern of a mask to a substrate. Moreover, it can apply also to the aligner for the liquid crystal which exposes a liquid crystal display element pattern on the glass plate of a square shape, and the aligner for manufacturing the thin film magnetic head, for example, without being limited to the aligner for semiconductor manufacture as a use of an aligner. It is possible to use it for the light source of the aligner by this invention not only by g line (436nm), i line (365nm), KrF excimer laser (248nm), ArF excimer laser (193nm), and F2 laser (157nm) but by any light source of the wavelength of a vacuum-ultraviolet region. The scale factor of projection optics not only of a contraction system but an expansion system being sufficient is natural further again.
[0104] The aligner by the explanation mentioned above is equipped with the chamber which is not illustrated [which intercepts the optical path of most illumination-light study systems from the open air], and the desiccation nitrogen gas (N2) which stopped oxygen content very low through piping is supplied in [whole] a chamber. Nitrogen gas is supplied also to the whole space inside the lens-barrel of projection optics 23 (space between two or more lens elements) through piping, and the magnitude of attenuation on the optical path of ultraviolet pulsed light is stopped very low. In addition, supply of desiccation nitrogen gas may be performed by preparing piping for between [every] the lens elements which constitute an illumination-light study system and projection optics. Moreover, in order to intercept between the chamber of an illumination-light study system, and projection optics 23 (i.e., the surroundings of a reticle stage 18) from the open air, a reticle room is constituted, in order to intercept between projection optics 23 and wafers 25 (i.e., the surroundings of the wafer stage 27) from the open air, a wafer room is constituted, and you may make it supply desiccation nitrogen gas to each **. Or the firm gas (flow) of the desiccation nitrogen gas may be carried out between the chamber of an illumination-light study system, and projection optics 23, and between projection optics 23 and a wafer 25, without constituting a reticle room and a wafer room.
[0105] When supply of desiccation nitrogen gas has the high confidentiality of the above-mentioned chamber or the lens-barrel of projection optics 23, once perfect substitute with atmospheric air is performed, it does not need to be carried out complicated. However, these impurities are removed by a chemical filter and the electrostatic filter, carrying out the flow of the nitrogen gas by which temperature control was carried out compulsorily within an optical path in consideration of the permeability fluctuation to which a water molecule, a hydrocarbon molecule, etc. which are produced from various kinds of material (** material, coat material, a binder, a coating, a metal, ceramics, etc.) which exists in an optical path adhere on the surface of an optical element, and happen. As for piping for supply which supplies desiccation nitrogen gas, it is desirable for generating of impurity gas (and degasifying) to form by various fluorine polymer, such as little material, for example, stainless steel, tetrafluoroethylene, and tetrafluoroethylene-TERUFURUORO (alkyl vinyl ether) and a tetrafluoroethylene-hexafluoro propene copolymer. Moreover, inert gas, such as helium (helium), an argon (Ar), a krypton (Kr), a xenon (Xe), and a radon (Rn), can also be used instead of desiccation nitrogen gas.
[0106] In the above explanation, although the laser beam from excimer laser was used for exposure light, the single wavelength light of the infrared region oscillated from distribution feedback mold (DFB) semiconductor laser and fiber laser or a visible region may be amplified with the fiber amplifier with which both the erbium (Er) or the erbium, and the ytterbium (Yb) were doped, and the higher harmonic which carried out wavelength conversion of the amplification light at ultraviolet radiation using the nonlinear optical crystal may be used. if oscillation wavelength of for example, single wavelength laser is made into within the limits of 1.544-1.553 micrometers -- a 8 times as much higher harmonic, i.e., the oscillation wavelength of ArF excimer laser, as the range of 193nm - 194nm -- ** -- the ultraviolet radiation of the same wavelength is obtained mostly. the case where oscillation wavelength of single wavelength laser is made into within the limits of 1.57-1.58 micrometers -- a 10 times as much higher harmonic, i.e., the oscillation wavelength of F2 laser, as the range of 157nm - 158nm -- ** -- the ultraviolet radiation of the same wavelength is obtained mostly. furthermore -- if a 7 times as much higher harmonic as the range of 147nm - 160nm is acquired when making oscillation wavelength

of single wavelength laser into within the limits of 1.03-1.12 micrometers, and a 157-158nm 7 times as many higher harmonic as this is especially taken when oscillation wavelength is 1.09-1.106 micrometers — the oscillation wavelength of F2 laser — ** — the ultraviolet radiation of the same wavelength is obtained mostly. As single wavelength oscillation laser in this case, for example, ytterbium dope fiber laser is used.

[0107] The aligner by the explanation mentioned above adjusts each optical axis of two or more optical elements which constitute an illumination-light study system, respectively, is arranged in an illumination-light study system chamber, adjusts the optical axis of two or more lenses, respectively, and constitutes projection optics 23. Furthermore, while arranging the reticle stage constituted from many machine parts movable to the reticle interior of a room, the wafer stage constituted from many machine parts in the image surface side of projection optics 23 is arranged. And after connecting electric wiring to the driving parts which constitute a reticle stage and a wafer stage, while performing comprehensive adjustments (electric adjustment, adjustment of operation, etc.), the aligner mentioned above can be manufactured by connecting piping for supplying gas to an illumination system chamber, projection optics, and a reticle room, and performing supply of evacuation or inert gas. As for the above activity, it is desirable to be carried out in the clean room where temperature management was performed.

[0108] A semiconductor device is manufactured through the step which performs the engine performance and engine-performance layout of a device, the step which manufactures the reticle based on this layout step, the step which manufactures a wafer from a silicon material, the step which imprints the pattern of a reticle to a wafer with the aligner mentioned above, a device assembly step (a dicing production process, a bonding production process, and a package production process are included), an inspection step, etc.

[0109] If correspondence with each component in a claim and each component in the gestalt of implementation of invention is explained The wafer 25 of eye ** (n-1) to a predetermined side and a photosensitive substrate to the 1st predetermined side [a wafer 25] 1-K(n-1) A to the 1st attenuation factor to the 2nd attenuation factor [1-K(n-1) B] 1-KnB to the 2nd predetermined side to the 3rd attenuation factor [the n-th wafer 25] deltad to the attenuation factor of the optical system 23 before the m-th wafer 25 carries out at difference and 1-KdmB carries out a predetermined time exposure in the 3rd predetermined side A reticle 16 to the attenuation factor of the optical system 23 after 1-KdmA carries out a predetermined time exposure on a mask a coefficient k — a predetermined coefficient — a laser light source 1 — the light source for exposure — the integrator sensor 10 and the illuminance sensor 28 correspond to a measurement means, and a control circuit 40 corresponds [the illuminance sensor 28] to a control means and a prediction means at an electric eye, respectively. Moreover, with the 1st predetermined side, it corresponds to the 1st shot field of the 1st wafer 25, and corresponds to the 1st shot field of the 2nd wafer 25 with the 2nd predetermined side. However, in performing double exposure to the shot field of a wafer 25, the 1st predetermined side and the 2nd predetermined side show the same shot field.

[0110]

[Effect of the Invention] As explained to details above, according to this invention, it has the following operation effects.

(1) claim 1- in 6 or 19 invention, with the 1st attenuation factor of optical system and the 2nd attenuation factor which were measured after imprinting, before imprinting the image of a pattern on the 1st [of an exposure object] predetermined side Since the light exposure of the exposure light to the 2nd predetermined side was controlled based on the 3rd attenuation factor of the optical system measured before imprinting the image of a pattern on the 2nd [of an exposure object] predetermined side Even if it changes the attenuation factor of an illumination-light study system or projection optics while exchanging an exposure object or carrying out alignment, an exposure object can be exposed proper.

(2) claim 8- in 14 or 20 invention, with the 1st attenuation factor of optical system and the 2nd attenuation factor which were measured after imprinting, before imprinting the image of a pattern on the 1st [of an exposure object] predetermined side The 1st control method which controls the light exposure of the exposure light to the 2nd predetermined side based on the 3rd attenuation factor of the optical system measured before imprinting the image of a pattern on the 2nd [of an exposure object] predetermined side, And before imprinting the image of a pattern on the 3rd [of an exposure object] predetermined side, the predetermined time exposure of the exposure light is carried out at optical system so that exposure light may not be irradiated on the 3rd predetermined side. Since it has the 2nd control method which controls the light exposure of the exposure light to the 3rd predetermined side based on the attenuation factor of optical system with the back before carrying out a predetermined time exposure and the light exposure of exposure light was controlled by one of the control methods For example, even when attenuation factor fluctuation of an illumination-light study system or projection optics is large and cannot expose an exposure object proper by the light exposure control by the 1st control method, an exposure object can be exposed proper by the 2nd control method.

[0111] (3) In invention of claims 15 and 16, carry out the predetermined time exposure of the exposure light at optical system, moving the mask with which the pattern was formed in the predetermined direction before imprinting the image of a pattern on the predetermined side of an exposure object. Since the light exposure of the exposure light to the predetermined side of an exposure object was controlled based on the attenuation factor of the optical system based on the light-receiving result of the exposure light which received light behind before carrying out a predetermined time exposure and For example, since a mask is fixed and it approaches according to the conditions at the time of exposure compared with the case where a predetermined time exposure is carried out, the precision of control is raised.

(4) Since the exposure light which passed through the outside of the optical axis of optical system and a shaft is received by the light sensing portion to coincidence, respectively, the attenuation factor of optical system is measured and light exposure was controlled by invention of claim 17 according to this attenuation factor, if the exposure light received by the light sensing portion is averaged and an attenuation factor is measured for example, even when the attenuation factors of optical system differ out of an optical axis and a shaft, the light exposure of exposure light is controllable by the average.

[0112] (5) The 1st light-receiving method which receives the exposure light which passed the optical axis of optical system in invention of claim 18, And since either of the 2nd light-receiving method which receives the exposure light which passes through the outside of an optical axis and a shaft is chosen, the attenuation factor of optical system is measured and the light exposure of exposure light was controlled according to this attenuation factor For example, if the 1st light-receiving method is chosen to control strictly the light exposure of one point on an exposure object, and the 2nd light-receiving method is chosen to stop the exposure nonuniformity on an exposure object, it will become possible to control light exposure according to the purpose.

(6) Since according to invention of claims 21 and 22 an attenuation factor time amount change prediction property is computed by (1) mentioned above and (2), exposure is controlled based on this prediction property and semiconductor DEBAIZU was manufactured, the manufacture yield of a semiconductor device can be improved.

[Translation done.]

DOCUMENT 3/4
DOCUMENT NUMBER
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1. JP,2000-091207,A
2. JP,2001-035777,A
3. JP,2001-110710,A
4. JP,10-092727,A(1998)

JAPANESE [JP,2001-110710,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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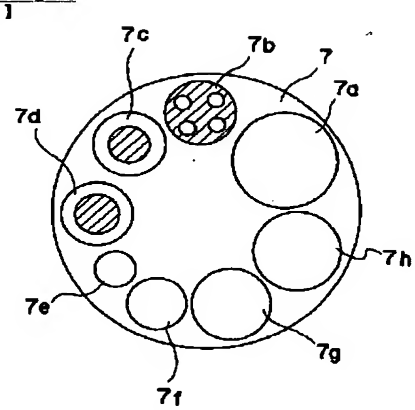
DRAWINGS

[Drawing 2]
【図 2】



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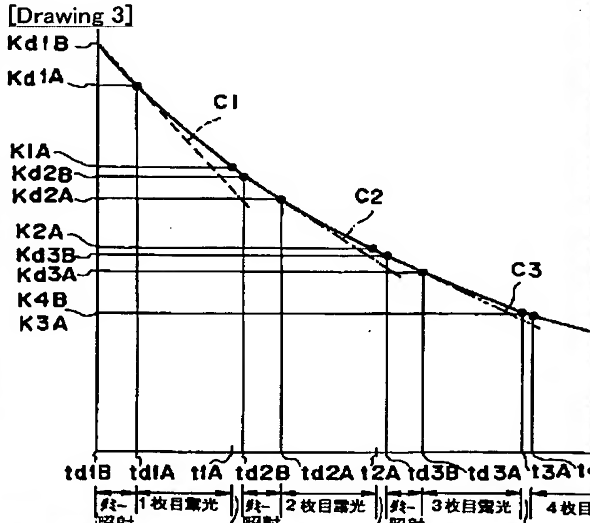

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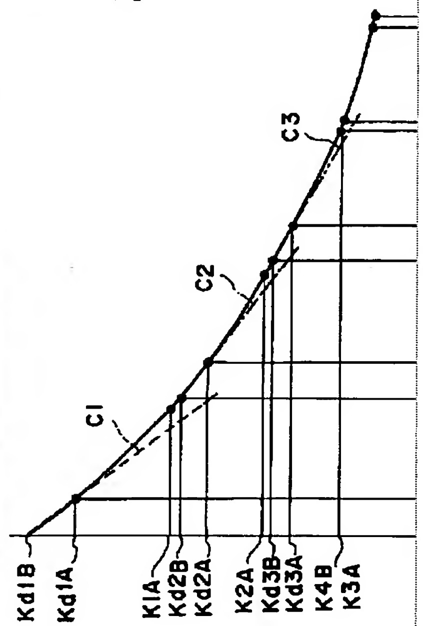
【図 3】



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